Original Article

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Physiology Section

An Analysis of Dynamic Pulmonary Functions of Hypothyroid Patients

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ABSTRACT

Introduction: Hypothyroidism is a silent epidemic of our times. In India, the prevalence of hypothyroidism is 11%. The effect of hypothyroidism on respiratory system is debatable with studies suggesting both obstructive and restrictive disease patterns. The symptoms range from mild dyspnoea to life-threatening respiratory failure. This study emphasizes the effect of hypothyroidism on dynamic respiratory functions.

Aim: To find out the changes in dynamic respiratory functions (FVC, FEV1, FEV1% and PEFR) in both male and female hypothyroid patients within age group of 18-45 years.

Materials and Methods: This cross-sectional study was conducted in Jubilee Mission Medical College, Thrissur, Kerala, India. Total number of 60 newly detected cases of both sexes in 18-45 years age group attending endocrinology outpatient department were enrolled. Patients with previous respiratory diseases and history of smoking were excluded. Proforma was filled up followed by clinical examination. Spirometry was performed using a computerised spirometer 'microQuark'. The data was analysed by paired t-test and Analysis of Variance (ANOVA) test.

Results: The mean of the observed values in all the dynamic pulmonary parameters showed highly significant difference from the predicted mean of the parameters ($p<0.001$). They also decreased considerably with age, gender and BMI which were statistically significant ($p<0.05$).

Conclusion: The above findings suggest that respiratory abnormality in newly detected cases of hypothyroidism shows a mixed pattern. This highlights that while investigating a patient with respiratory disorder, the thyroid status should always be probed into, as the effects of hypothyroidism can be reversed with proper treatment.

Keywords: Body mass index, Forced expiratory volume, Thyroid disorders

INTRODUCTION

Research related to thyroid disorders has now occupied the center stage as the incidence of thyroid disease in Indian population has escalated. The fact that it is a silent epidemic adds to the curiosity of researchers. India's epidemiological survey highlights the increased prevalence of thyroid diseases [1]. Clinically they range from hyperthyroidism to hypothyroidism. Since hypothyroidism presents with various non specific symptoms, it is difficult to get correctly diagnosed which can lead to complications in future. In India, the prevalence of hypothyroidism is 11% when compared to 2% in United Kingdom and 4.6% in United States of America [2]. Even though India is in the post-iodization phase, more than 71 million people are affected by goiter and iodine deficiency disorders as per the latest data [3].

Apart from the metabolic and thermoregulatory effects, thyroid hormones have influence on all the systems. The common presenting complaints in hypothyroidism are fatigue, weight gain, intolerance to cold, oedema, dyspnoea, palpitations, body pain, hair loss, dry skin etc. Normally, the hormones have effects on central ventilatory drive and strength of respiratory muscles. But in hypothyroidism, decreased levels of hormones cause myopathies in inspiratory and expiratory muscles, alveolar hypoventilation and depressed hypoxic ventilatory drive [4].

Considering the emergence of hypothyroidism in population and their widespread effects, this study was designed to highlight the effects of this disorder on the respiratory system.

The aim of study was to assess the changes in dynamic pulmonary functions FVC, FEV1, FEV1% and PEFR in newly detected hypothyroid patients of 18-45 years age group and to analyse their changes with age, gender and BMI.

MATERIALS AND METHODS

This cross-sectional study was conducted in Department of Physiology, Jubilee Mission Medical College and Research Institute, Thrissur, Kerela, India. Study protocol was approved by Institutional Ethics Committee (45/14/IEC/JMMC & RI) and the study was done for a period of seven months. Total number of 60 hypothyroid patients in the age group of 18-45 years were selected randomly from endocrinology outpatient department. Study population included both males and females satisfying inclusion and exclusion criteria. All patients were either newly detected or on treatment for less than six months. Those with hyperthyroidism, pregnancy, previous respiratory diseases or history of smoking were excluded. Informed written consent was taken from all the patients. Proforma was filled up, clinical examination and anthropometry were done and spirometry was performed using a computerised spirometer 'microQuark'. The parameters taken into consideration were FVC, FEV1, FEV1% and PEFR.

STATISTICAL ANALYSIS

Results were tabulated in Microsoft office excel and analysed by Statistical Package for Social Sciences (SPSS) version 22.0. The statistical tests used were paired t-test and Analysis of Variance (ANOVA) test.

RESULTS

Demographic profile of the study group is shown in [Table/Fig-1]. It is important to notice that the mean value of BMI in 60 patients show 27.71±5.05 which is higher. The study group had 11(18%) males and 49(82%) females. A total of 65% had positive family history of thyroid disease and 35% had negative. The pulmonary functions showed significant decrease in the newly detected hypothyroid patients. From [Table/Fig-2], it is clear that the percentage predicted

Variables	Mean±SD
Age (years)	35.75±7.3
Height (cm)	159.3±6.58
Weight (kg)	70.63±14.6
BMI (kg/m^2)	27.71±5.05
TSH (m IU/ml)	26.87±5.11
Males	11
Females	49

[Table/Fig-1]: Demographic profile of study group.

Variables	Predicted value (Mean±SD)	Measured value (Mean±SD)	% predicted	p-value
FVC	3.38±0.58	1.67±0.65	49	0.001**
FEV1	2.84±0.48	1.12±0.48	39	0.001**
FEV1%	84±2.00	68±16.7	^	0.001**
PEFR	2.87±1.05	1.44±0.85	50	0.001**

[Table/Fig-2]: Analysis of pulmonary functions of hypothyroid patients.
*p-value <0.05- significant
**p-value<0.001- highly significant
^ FEV1% is calculated as FEV1/FVC. Hence percentage predicted is 68

values of FVC was 49, FEV1- 39, FEV1%- 68 and PEFR-50. The observed values were compared with predicted values by paired t-test and results were found to be highly significant (p<0.001). The variation of these parameters with age, gender and BMI was also assessed.

With age, all the parameters showed significant deterioration [Table/Fig-3] and there was high significance when observed values were compared with predicted values in each of the subgroups of age (p-value <0.001). The variation was analysed by ANOVA between the three age groups which was insignificant [Table/Fig-4]. Analysis of pulmonary functions in different gender showed that FVC, FEV1 and PEFR had decreased values when comparing with predicted values as seen in [Table/Fig-5]. These values were statistically significant. Comparison of predicted and observed values in different groups of BMI also showed difference and in the overweight group all parameters had decreased significantly (p<0.001) as shown in [Table/Fig-6]. When analysis of values between three groups was done, no statistical significance was obtained [Table/Fig-7].

Pulmonary Function Test (PFT)	Age groups								
	18-25(n=6)			26-35(n=25)			36-45(n=29)		
	Predicted	Measured	p-value	Predicted	Measured	p-value	Predicted	Measured	p-value
FVC	3.6±1.03	1.68±1.1	0.001**	3.5±0.4	1.8±0.67	0.001**	3.2±0.4	1.5±0.5	0.001**
FEV1	3.1±0.8	1.1±0.7	0.001**	2.9±0.47	1.1±0.4	0.001**	2.6±0.32	1.09±0.4	0.001**
FEV1%	88.08±1.4	67.2±13.1	0.012**	85.1±0.9	66.3±12.8	0.001**	82.6±0.8	70.6±20.2	0.003**
PEFR	3.5±1.1	2.3±0.7	0.001**	2.7±0.9	1.7±0.9	0.001**	2.3±1.1	1.3±0.7	0.001**

[Table/Fig-3]: Analysis of variation of pulmonary functions in hypothyroid patients with age.
*p-value <0.05- significant
**p-value<0.001- highly significant

PFT parameters	F-value	p-value
FVC	0.995	0.376
FEV1	0.124	0.884
FEV1%	0.448	0.641
PEFR	0.484	0.619

[Table/Fig-4]: Variation of PFT parameters between age groups.

DISCUSSION

Hypothyroidism is a clinical entity which affects all the systems in our body so that the presentation of the disease is also nonspecific. In the present study of newly detected hypothyroid patients, the changes in respiratory parameters were taken into consideration. Thyroid disorders mostly affects females because, oestrogen has direct effect on thyroid follicular cells and increases thyroid binding globulin levels [5]. Another most probable cause explained was the presence of Skewed X chromosome inactivation [6]. In our study, 82% patients were females and 18% were males. Almost 65% of patients in the study group had positive family history of thyroid disease. This supports the existing data regarding the high genetic predisposition of thyroid diseases. The study of Manji N et al., agrees with this [7].

On comparing the predicted and observed mean of 60 patients, all the pulmonary parameters showed significantly decreased values which points to a mixed pattern of respiratory disorder in hypothyroidism. Our findings are agreed by Bassi R et al., and Siafakas NM et al., [4,8]. But there are several studies having conflicting reports. The study by Roel S et al., and Sharifi F et al., showed restrictive pattern and Bhuvaneswari T et al., concluded their findings as having obstructive pattern [9-11]. The pathophysiology behind the deterioration in pulmonary functions is attributed to various causes. Most important is defective ventilatory drive, hypoxic drive is affected earlier than hypercapnic drive. Another explanation is decreased respiratory muscle strength in which proportion of Type-1 fibers in diaphragm and intercostal muscles is changed. There can also be the deposition of glycosaminoglycans in pulmonary interstitial tissue causing osmotic oedema and fluid retention [4].

The deterioration of lung functions with increasing age is already known but in untreated hypothyroidism these changes are aggravated. With age, rigidity of chest wall increases and respiratory muscle strength decreases. There are significant variations in pulmonary mechanics, gas exchange and ventilatory control [12]. Our study also showed significant decrease in pulmonary functions with age in hypothyroid patients.

The changes in lung functions with gender were also significant with males having higher values. Analysis in both genders also points out the mixed pattern of disorder. But this finding was against that of Koral L et al., [13]. Anatomical and physiological differences exist between the respiratory systems of males and females. Females have lesser vital capacity, small diffusion surface and reduced airway diameter affecting the lung volumes and dynamic pulmonary functions. Oestrogen and progesterone also influence this [14].

Hypothyroidism causes obesity which increases BMI. In this study group of 60 patients, 45 had overweight, 13 were normal and only two were underweight. Analysis of pulmonary parameters with increasing BMI was done and results showed significant decrease in all parameters in overweight group. These findings were similar to Maiti SR et al., and Col NF et al., [15,16]. Overweight causes decreased chest wall compliance and reduced downward movement of diaphragm. FRC is also reduced [17].

PFT parameters	Gender					
	Males (n=11)			Females (n=49)		
	Predicted	Measured	p-value	Predicted	Measured	p-value
FVC	4.33±0.78	2.11±0.93	0.001**	3.16±0.18	1.57±0.54	0.001**
FEV1	3.59±0.67	1.4±0.68	0.001**	2.67±0.19	1.06±0.41	0.001**
FEV1%	83.02±1.26	69.6±21.46	0.065	84.5±2.04	68.29±15.79	0.001**
PEFR	3.65±0.41	1.73±1.1	0.001**	3.17±0.41	1.37±0.79	0.001**

[Table/Fig-5]: Analysis of pulmonary functions in male and female hypothyroid patients.
*p-value <0.05- significant; **p-value<0.001- highly significant

PFT	BMI								
	<18(n=2)			18-24.99(n=13)			≥25(n=45)		
	Predicted	Measured	p-value	Predicted	Measured	p-value	Predicted	Measured	p-value
FVC	4.03±1.3	1.8±1.6	0.06	3.35±0.6	1.5±0.5	0.001**	3.3±0.5	1.6±0.6	0.001**
FEV1	3.4±0.9	1.01±0.7	0.029*	2.83±0.5	1.2±0.5	0.001**	2.8±0.46	1.1±0.4	0.001**
FEV1%	86.4±4.8	59.8±10.5	0.09	84.5±1.9	76.3±16.9	0.112	84.05±1.8	66.6±16	0.001**
PEFR	4.7±1.2	2.07±2.1	0.07	3.58±1.3	1.47±0.72	0.001**	3.5±0.9	1.4±0.8	0.001**

[Table/Fig-6]: Variations of pulmonary functions with BMI in hypothyroid patients.
*p-value <0.05- significant; **p-value<0.001- highly significant

PFT parameters	F-value	p-value
FVC measured	0.303	0.740
FEV1 measured	0.286	0.752
FEV1% measured	2.037	0.140
PEFR measured	0.586	0.560

[Table/Fig-7]: Variation of PFT parameters between groups of BMI.

Mixed pattern of respiratory disorder can be caused by parenchymal and non parenchymal causes. But the reported cases of this pattern are only 3.5%-4% [18]. One of the common causes includes obesity. Others are sarcoidosis, cryptogenic pneumonia, Langerhan's cell histiocytosis [19]. Researchers have observed hypothyroidism having mixed pattern of respiratory disorder. All these changes are reversible with adequate supplementation of levothyroxine treatment [12] but complete reversibility depends on the duration of disease. Early diagnosis and treatment can prevent the complications and improve the quality of life.

LIMITATION

Equal number of patients was not taken in different subgroups like age, gender and BMI.

CONCLUSION

Newly detected hypothyroidism causes mixed pattern of respiratory disorder. There are significant variations in pulmonary functions with age, gender and BMI in these patients, suggesting the importance of early diagnosis and treatment.

ABBREVIATIONS

FVC: Forced Vital Capacity
FEV1: Forced Expiratory Volume in first second
FEV1%: FEV1/FVC
PEFR: Peak Expiratory Flow Rate
PFT: Pulmonary Function Test
FRC: Functional Residual Capacity

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